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ABSTRACT

California is one of the few states in which school districts have a legal responsibility for accidents involving students while they are participating in assigned school activities. This guide was prepared to help school administrators and teachers evaluate their safety instruction programs and industrial education facilities in accordance with the legal requirements of California's education and government codes and occupational safety and health legislation. The first section of the guide quotes parts of the codes on accident liability and required safety instruction, legal provisions for school eye safety, industrial education work station safety, and legal bases for teacher negligence. A safety instruction program in industrial education is outlined in the second section. The third presents safety requirements applicable to industrial education facilities and equipment from the California Occupational Safety and Health Act, as detailed in general industry safety orders which cover safety requirements for business and industry. A facility safety inspection list is appended. (EP)

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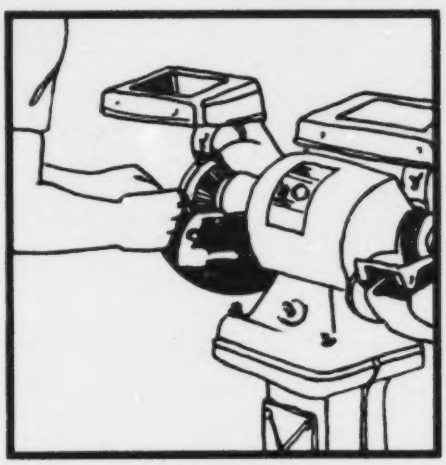
Industrial Education Safety Guide



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CALIFORNIA STATE DEPARTMENT OF EDUCATION Wilson Riles—Superintendent of Public Instruction Sacramento, 1978

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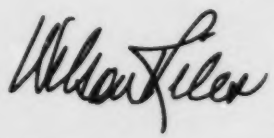
Foreword

Educators in California are always looking for ways to improve their services to the students enrolled in their schools. This commendable professional attitude helps explain why California's educational programs in general and its industrial education programs in particular have gained wide recognition for their quality.

All teachers wish to safeguard their students and to help them live increasingly efficient and happy lives. Industrial education teachers can make training in safety an integral part of every task performed.

The *Industrial Education Safety Guide* presents essential safety instruction in the use of tools and equipment. Emphasis is given to the importance of relating safety instruction to the daily life of the student, both in the classroom and in industry when he or she is employed.

The purpose of this publication is to provide a guide for safety instruction and a means of evaluating the instructional program and the industrial education facilities. The material in the publication was prepared (1) to meet the requirements of industrial education teachers at all levels; (2) to serve as a basis for reorganizing existing safety programs and updating facilities; (3) to meet certain of the legal requirements set forth in California's Education Code and Government Code, both from the standpoint of accident liability and required safety instruction; and (4) to provide a basis for carrying out the rules and regulations of the Division of Industrial Safety of the California State Department of Industrial Relations (CAL/OSHA, California Occupational Safety and Health Act of 1973). I am certain the information presented in this publication will be of great value in helping to improve safety instruction in California's industrial education programs.



Superintendent of Public Instruction

Preface

The *Industrial Education Safety Guide* was prepared to provide school administrators and teachers with a means of evaluating their safety instruction programs and industrial education facilities in accordance with the legal requirements set forth in the California Education Code, the California Government Code, and the California Occupational Safety and Health Act of 1973. This publication is based on current terminology and equipment nomenclature as a result of extensive research conducted by Earl Smith, Professor, California State University, Long Beach, with the assistance of Chris Almeida, Consultant in Industrial Education, Bureau of Industrial Education, State Department of Education.

Teachers of industrial education in California have a need to keep current with the changing requirements of new laws that affect safety education. This publication should help meet that need.

The *Industrial Education Safety Guide* should be of invaluable assistance to those responsible for evaluating safety instruction in industrial education courses in California's public schools.

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The Schools and the Law

California is one of the few states in which school districts have a legal responsibility for accidents that involve students while they are participating in school activities to which they have been lawfully assigned. Government Code sections 815.2 and 820.2 (Statutes 1963, Chapter 1681) include the following:

> A public entity is liable for injury proximately caused by an act or omission of an employee of the public entity within the scope of his [or her] employment if the act or omission would . . . have given rise to a cause of action against that employee or his [or her] personal representative.
>
> Except as otherwise provided by statute, a public employee is not liable for an injury resulting from his [or her] act or omission where the act or omission was the result of the exercise of the discretion vested in him [or her], whether or not such discretion be abused.

Liability of School Districts, Administrators, and Employees

To meet the provisions of these sections of the Government Code, school districts should provide working conditions that are safe and instruction that is appropriate for the type of work the students are doing. In addition, Education Code Section 35208 (1017)[1] requires that school districts protect themselves and their employees by carrying liability insurance. This section of the code includes the following:

> The governing board of any school district shall insure against:
>
> (1) The liability . . . of the district for damages for death, injury to a person, or damage or loss of property; and
>
> (2) The personal liability of the members of the board and of the officers and employees of the district for damages for death, injury to a person, or damage or loss of property caused by the negligent act or omission of the member, officer or employee when acting within the scope of his [or her] office of employment.

[1]The new (reorganized) Education Code is now in effect. Throughout this publication the old section number for each of the Education Code sections presented is given in parentheses.

School Eye Safety Law

Legal provisions concerning eye safety in the schools are presented in Education Code sections 32030 (12090) through 32034 (12094). The most important provisions are the following:

> It shall be the duty of the governing board of every school district . . . to equip schools with eye protective devices . . . for the use of all students, teachers, and visitors.
>
> . . . It shall be the duty of the superintendents, principals, or teachers charged with the supervision of any class in which any such course is conducted, to require such eye protective devices to be worn by students, teachers, and visitors . . .
>
> The eye protective devices shall be worn in courses including, but not limited to . . . industrial arts shops or laboratories . . . at any time at which the individual is engaged in, or observing, an activity or the use of hazardous substances likely to cause injury to the eyes.
>
> Hazardous substances likely to cause physical injury to the eyes include materials which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition or other means as defined in the California Hazardous Substances Labeling Act.
>
> Activity or the use of hazardous substances likely to cause injury to the eyes includes, but is not necessarily limited to, the following:
>
> (1) Working with hot molten metal.
>
> (2) Milling, sawing, turning, shaping, cutting, grinding, and stamping of any solid materials.
>
> (3) Heat treating, tempering, or kiln firing of any metal or other materials.
>
> (4) Gas or electric arc welding.
>
> (5) Repairing or servicing of any vehicles, or other machinery or equipment.
>
> (6) Working with hot liquids or solids or with chemicals which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition, or other means.

Sale of Protective Devices at Cost

In accordance with Education Code Section 32033 (12093), eye protective devices may be sold to pupils and teachers at a price that will not exceed the actual cost of the eye protective devices to the school or governing board.

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Use of Prescription Lenses

Prescription lenses that meet the standards set forth in Education Code Section 32032 (12092) may be used by persons doing the work described in Section 32031 (12091), Item 6, in a classroom under the supervision of appropriate personnel.

Safety in the Work Station

The basic work station in an industrial education facility is defined in Education Code Section 49320 (12095). This section, which includes a provision for industrial safety education, is as follows:

> A basic work station in industrial education is defined as an assigned location where a student normally spends the majority of his [or her] class time performing the operational functions necessary to meet the performance objectives and goals of the course, including industrial safety education. For these purposes, the number of students in any industrial education facility or laboratory in elementary and secondary programs shall not exceed the number of basic work stations designed for the number of students assigned, as determined by the local governing board of the school district.

To implement the intent of Section 49320 and to comply with its provisions, the following procedure is suggested:

1. The teacher should prepare a course outline that includes the goals and performance objectives that the students are expected to achieve.
2. The performance objectives should describe the manipulative skills that the students are expected to learn and the equipment that they will use in learning these skills.
3. The amount of time that the student will be required to work on each piece of equipment in the facility should be stated.
4. Any specific safety factors, rules, and regulations applicable to the specific facility should be stated in the course outline.
5. The course outline should then be submitted to the principal, district administrators, and members of the local board of education for approval.

When the board members have approved the teacher's course outline, they actually have limited the enrollment in the industrial education facility for which the course outline was written. The reason for this is that Section 49320 states that "... the number of students in any industrial education facility or laboratory in elementary and secondary programs shall not exceed the number of basic work stations."

Negligence

California laws place the liability for student accidents and injuries with the school district; however, the instructor is responsible for both the safe environment of the shop and the administration of the safety program. To prevent student injury and the possibility of a liability suit, the teacher of industrial education must not be negligent in the performance of a teaching assignment. Any of the following acts could provide a basis for accusation or inference of negligence on the part of the instructor:

1. Failure to provide proper instruction
2. Failure to supervise the assigned instructional area while classes are in session
3. Failure to correct a known, dangerous condition in the assigned area
4. Failure to prevent students from exposure to a known, dangerous condition until it can be corrected by the teacher or by the district

The industrial education teacher is responsible for instructing students in the safe use of tools and equipment before the students are allowed to participate in the laboratory activities in which the tools and equipment are used.

The teacher also is required to remain in the instructional area while students are engaged in any activity that might result in an accident.

The physical condition of the laboratory and its equipment also is the responsibility of the industrial education teacher. The teacher should conduct frequent inspections of the laboratory to ensure a safe environment for the students. Inspection records should be maintained, and any unsafe condition should be corrected as soon as possible. If a particular condition cannot be corrected by the instructor, it should be reported in writing to the district. The students should not be exposed to the unsafe condition.

Although a teacher may have requested that an unsafe condition be corrected or eliminated, he or she is still responsible for preventing students from being exposed to the condition. If a teacher is aware of an unsafe condition and permits students to be exposed to that condition, the teacher could be considered negligent.

Introduction to a Program of Safety

A well-coordinated study plan should include safety instruction that is geared to the correct use of the equipment in the industrial education facility. By having such a plan, school administrators will be doing the following:

1. Help the student work more efficiently.
2. Cause the student to become aware of safety practices that apply to daily living in school, around the home, and at work.
3. Aid in protecting the teacher and school district from possible legal actions claiming negligence.
4. Make it easier for the teacher to offer required instruction in accident and fire prevention.
5. Help the student develop a positive attitude toward working safely.

Safety should be emphasized in every phase of instruction. The industrial education teacher can give real meaning to safety because in all laboratory activities the need for strict adherence to safety rules is apparent.

Whenever possible, the teacher should explain how certain safe practices in the shop relate to other activities the student experiences daily at home and at work.

Safety Instructions for the Industrial Education Program

A successful industrial education program requires that the students understand the reasons and advantages of the activities that take place. In explaining and demonstrating the correct, safe procedure to follow in using a tool or a machine, the teacher should give the reasons and advantages for each step. The following general safety instructions for students can be applied to all areas of industrial education:

1. Ask the teacher to approve all work that you plan to do.
2. Report all injuries, even though slight, to the teacher immediately.
3. Wear suitable eye protection when engaged in any activity where eye hazards may exist.
4. Be sure your clothes are safe and suitable for shop work. Remove or fasten any loose clothing. Roll loose sleeves above the elbows. Keep hair away from equipment in operation. (Long hair must be confined.)
5. Observe rules concerning the operator's zone.
6. Cooperate with other classmates in the student management of the shop.
7. Caution other students who may be violating a safety rule.
8. Obtain permission from the teacher before using any power equipment.
9. Report to the teacher or shop supervisor any equipment that does not seem to work properly.
10. Keep tools and materials from projecting over the edge of benches whenever possible.
11. Use a brush or piece of wood to clear away dry chips, and use a rag to clean oily areas.
12. Keep the floor clear of scraps and litter.
13. Wipe up immediately any liquids spilled on the floor.
14. Keep bench and cabinet drawers and locker doors closed.
15. Place oily rags and other combustible materials in a covered metal container.
16. Exercise care in handling large, heavy, or long pieces of material.
17. Practice emergency procedures to follow in case of earthquake, fire, or other disaster.

Some of the preceding safety instructions will be explained in detail in the following paragraphs.

To "ask the teacher to approve all work" will (1) ensure the best, easiest, and safest way to do a job successfully; and (2) protect all class members from accidents caused by the careless or incompetent use of tools and machines.

When the student has to go to the teacher for approval, the teacher can help the student plan the project. One of the purposes of industrial education is to assist the student in developing an organized procedure. Submitting a plan of procedure should be a required step for the student to take in securing the teacher's approval. Whether approval should be given for the entire job depends

upon the competence and maturity of the individual. Under no circumstances should a student be allowed to use tools or machines without the teacher's approval. Accident reports show that many mishaps in industrial education facilities occur when students use tools and machines for unapproved purposes.

To "report all injuries, even though slight, to the teacher immediately" will (1) allow the teacher to give immediate attention to injuries; (2) permit the teacher to administer first aid for minor cuts, abrasions, burns, or bruises; and (3) assist the teacher in correcting situations that cause accidents.

Adherence to the practice of having all injuries, even though slight, reported to the teacher protects the students and the school. Good judgment should be used in deciding upon the seriousness of an injury and the type of action that should be taken. Each school district usually has a definite procedure that must be followed in case of a serious injury. Each shop should be equipped with a first-aid kit that contains a fresh supply of first-aid materials. All cuts, abrasions, burns, or bruises received by the students should be inspected by the teacher, and, when necessary, first aid should be administered.

In an industrial education facility, the teacher should clearly designate the operator's zone for each machine or piece of equipment. Only the operator should be allowed within the zone while the machine or equipment is in use. To "observe rules concerning the operator's zone" will (1) prevent others from bumping into the operator; (2) give the operator complete responsibility in the use of the machine; and (3) protect all members of the class from injuries caused by moving machine parts and flying pieces of material.

The designation of operators' zones, preferably by taped or painted lines, helps protect the students and the school. When operators' zones are clearly identified, the teacher will have greater success in conveying the following safety instructions: (1) "Make sure that all students are clear of the machine before turning on the power"; (2) "Start your own machine and remain with it until you have turned it off and allowed it to come to a complete stop"; and (3) "Stay clear of machines being operated by others." Although the designating of operators' zones is accepted practice, accident reports reveal that students other than the operators are being injured in areas that should have been indicated as operators' zones.

To "cooperate with other classmates in the student management of the shop" will (1) make the sharing in the responsibilities of shop management a satisfying experience; (2) allow each student a greater amount of time for shop work by the efficient handling of tools and materials; and (3) cause an equal division of the tasks necessary to maintain a desirable work environment.

If student management of the shop is to be successful, each student will have to understand the advantages of cooperating with his or her classmates. Students should share in the responsibilities of maintaining not only an orderly shop but also a safe one. Safety should be an integral part of the total operation. Each class member should be instructed to "caution other students who may be violating a safety rule."

To "obtain permission from the teacher before using any power equipment" will (1) ensure that the machine selected will provide the best, easiest, and safest method for doing the job; (2) give the teacher an opportunity to check the condition of the machine; and (3) give the teacher an opportunity to make certain that the class members are protected from accidents caused by the careless or improper use of equipment.

When the student is required to obtain permission before using equipment, the teacher can use this opportunity to give the student additional instruction. Whether permission should be given to the student for the entire job depends upon his or her competence and maturity. The first statement in each list of safety instructions should direct the student to "obtain permission from the teacher before using" the specified machine. This should be followed by instructions concerning steps to be taken before operating the machine. After the preparatory directions are given, a statement such as "Turn on the power (after permission is obtained)" should be listed as a double check. Permission first may have been given with a condition that certain instructions be followed concerning the use of jigs, special setups, or safety devices. A second check may be necessary, particularly for the inexperienced operator. Accident reports indicate that accidents often are caused by students who are using machines without permission and for unapproved purposes.

Planning the Safety Instructions

The teacher should use selected safety instructions as a guide in preparing a lesson plan on the correct use of each tool or piece of equipment. The instructions should be planned so that they will emphasize safe practices that will be covered in the first safety test.

The safety instructions should be printed on one side of a single sheet of paper. They can be used by each student for study and review. In addition, they should be displayed prominently on the equipment.

Evaluating the Safety Instructions

The administration of an industrial education safety test to all students will (1) make it possible for teachers to evaluate their safety instructions; (2) cause each student to acknowledge an understanding of the correct way to work in an environment of tools and machines; and (3) furnish written proof that safety instructions have been given to the students.

Results of a statewide study indicated that the majority of industrial education teachers and supervisors in California preferred the objective type of safety test. Of all the types of objective tests, the teachers overwhelmingly selected multiple-choice and completion-type tests, in that order, as the most valuable and most applicable. Examples of these are the following:

1. Multiple-choice item: Before using any power equipment, you should obtain permission from: (1) an advanced student; (2) the principal; (3) the teacher; (4) the office.
2. Completion-type item: Before oiling, cleaning, or adjusting a machine, you should allow the machine to come to a complete _____.

Safety is a positive and personal matter. Whenever possible, the safety test questions should emphasize the positive approach to safety education; e.g., "Do this for one of these reasons." The student's personal responsibility for safety should be stressed by aiming the questions at the student rather than at an impersonal someone; e.g., "You should do this for one of these reasons."

Recommendations for an Effective Safety Program

To have an effective safety program, the industrial education teacher should consider the following guidelines:

1. Emergency procedures in the event of fire, earthquake, nuclear attack, or other disaster should be explained at the first class meeting.
2. General safety instructions should be presented before students are permitted to engage in laboratory activities.
3. General safety tests should be given, and records should be maintained.
4. The instructor should give instruction and demonstrations on each tool and machine before students are permitted to use them.
5. Specific safety instruction and tests should be given on each power tool and other hazardous equipment.
6. Students should ask the instructor for permission to operate power equipment and other hazardous equipment.
7. The instructor should set a positive example by practicing all safety procedures in the laboratory.
8. The instructor should closely supervise students while they are operating machines and equipment.
9. Routine shop safety inspections should be conducted by the instructor, and records of the inspections should be maintained.
10. Unsafe conditions should be corrected. If repairs cannot be made immediately, proper barriers should be installed around the equipment to prevent its use.
11. Any machine or piece of equipment that is not in good working order should be properly tagged and turned off or disconnected, if possible.
12. Students should report unsafe conditions as soon as they are discovered.
13. All student accidents and injuries should be reported immediately to the instructor.
14. Accurate records should be kept of student accidents and injuries.
15. The service and repair requests should be in writing, and accurate records should be maintained.
16. Students should be encouraged to participate in making the shop a safe place for everyone in the class.
17. The safety laws and rules should be enforced in the shop at all times.
18. Under no circumstances should the instructor leave the designated instructional area during assigned class time.

Federal and State Legislation for Industrial Safety

Safety education always has been an extremely important objective of the industrial education program. The teacher and the school's administrators are responsible for providing a safe laboratory for student learning activities. In addition, the teacher is responsible for instructing and supervising the students during all activities in the laboratory. The safety education program, if it is based on the industrial safety practices, should prepare the students to work safely in school and in industry.

Within the past five years federal legislation has caused much emphasis to be placed on safety education. The Occupational Safety and Health Act (OSHA) was enacted by the United States Congress and became law on April 23, 1971. This law was designed specifically to eliminate unsafe working conditions in all areas of employment. Individual states are using this law as a guide for developing their own occupational safety and health programs. The federal law requires each state to enact legislation. In 1973 California passed the California Occupational Safety and Health Act (CAL/OSHA). It includes the following:

> The California Occupational Safety and Health Act of 1973 is hereby enacted for the purpose of assuring safe and healthful working conditions for all California working men and women by authorizing the enforcement of effective standards; assisting and encouraging employers to maintain safe and healthful working conditions; and by providing for research, information, education, training, and enforcement in the field of occupational safety and health.

Because the California Occupational Safety and Health Act affects schools as well as other agencies, the teachers of industrial education programs are covered as employees of a school district. The law does not treat students as employees, except in those cooperative education classes where they receive pay. However, students are instructed and supervised in the laboratories in the industrial education program in which the teacher is employed; therefore, the facilities must meet the requirements of the law. Details of this law are presented in *General Industry Safety Orders*, which covers all safety requirements for business and industry.

Industrial Education Facility Requirements

The following is an attempt to present only the safety requirements that are applicable to industrial education facilities and equipment. If additional information is needed, the teacher or administrator should refer to the appropriate safety regulations or seek help from the local office of the Division of Industrial Safety. The numbers in parentheses refer to the appropriate section of the *General Industry Safety Orders* or the *Electrical Safety Orders.*

Abrasive Wheels

Safety codes have been adopted for the protection of operators of abrasive wheels.

General machine requirements (3576). Stationary grinding machines must be sufficiently heavy and rigid so as to prevent dangerous vibration. They must be securely mounted on adequate and safe floors, benches, foundations, or other structures.

Permissible wheel exposure for periphery grinding–bench and floor stands (3578). The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as bench and floor stands should not exceed 90 degrees or one-fourth of the periphery.

Protective devices (3577). Abrasive wheels must be equipped with protection hoods. The hood guard should cover the spindle end, nut, and flange projections. The work rest should be kept adjusted closely to the wheel with a maximum opening of $\frac{1}{8}$ inch (0.3 cm) to prevent the work from being jammed between the wheel and the rest; jamming could cause the wheel to break.

Speed (3580). The recommended speed of abrasive wheels should be indicated on each wheel by the manufacturer. Abrasive wheels should not be operated in excess of the recommended speed.

Air Compressors (3518)

Air compressor intake lines should not be located in atmospheres that contain explosive concentrations of flammable gases or vapors. An air compressor discharge line with a block valve

between the air receiver and compressor must have a pressure-relieving safety device installed in the line between the compressor and block valve.

Aisles (3272)

Where aisles or walkways are required, machinery equipment, parts, and stock should be so arranged as to provide clear walkways or aisles not less than 24 inches (61 cm) wide and 6 feet 8 inches (2 m) high. All exits from the building should be free of obstacles and clearly identified.

Automotive Lifts (3543)

Automotive lifts should be marked with the name of the manufacturer, capacity of the lift, date of installation, and Division of Industrial Safety approval number.

Each hydraulic automotive lift must be equipped with a readily accessible direct control device that will automatically return to the neutral or "off" position when it is released by the operator. The floor surfaces under the lift should be kept reasonably free of oil or grease to minimize hazards.

Compressed Air and Gases (3301)

Compressed air or other compressed gases in excess of 10 pounds per square inch (69 kPa) should not be used to blow chips or dust from clothing while it is being worn. The use of compressed air for cleaning machines, tools, or parts thereof should be so controlled, or proper safety devices or safeguards used, as to reduce the possibility of injury to the eyes.

Doors (3235)

Every exit opening must be large enough to permit the installation of a door not less than 36 inches (91 cm) wide and 6 feet 8 inches (2 m) high. Revolving, sliding, or overhead rolling doors should not be used as required exits.

Electrical Requirements

Electrical safety codes have been adopted for the protection of operators of electrical machinery and equipment.

Approvals (2305.4). Electrical products, materials, devices, systems, or installations must be approved, listed, or labeled as conforming to applicable test standards established by the Underwriters' Laboratories, U.S. Bureau of Mines, National Institute for Occupational Safety and Health, or other OSHA-accredited testing laboratories and facilities.

Automatic restarting—magnetic switches and controls (2530.43). A motor-running overload device that can restart a motor automatically after overload tripping should not be installed unless it is approved for use with the motor it protects. A motor that can restart automatically after shutdown should not be installed if its automatic restarting can result in injury to persons.

Control and protective devices (2340.27). All switches, circuit breakers, fuses, or other control and protective devices should be located or arranged so that they may be safely operated, removed, or repaired.

Exposed wiring (2420.17). Open, exposed wiring should not be installed in any building or portion of a building.

Grounding-type receptacles, adapters, cord connectors, and attachment plug devices (2510.58). Grounding-type receptacles, adapters, cord connectors, and attachment plugs should be provided with one fixed grounding pole in addition to the circuit poles.

Mechanical protection (2340.26). Electrical conductors and equipment should be protected from physical damage.

Work space in front of electrical equipment (2340.16). Work space in front of any piece of electrical equipment should be at least 30 inches (76 cm) wide. This space should never be used for storage.

Exits (3228)

Every building or usable portion thereof must have at least one exit. At least two exits are required where more than 50 persons are occupying a school shop or vocational room.

Fire Classification and Protection

Safety codes have been adopted for the protection of those who work in industrial facilities.

Fire classification (6150). Fires have been classified as follows:

- **Class A.** Fires involving ordinary combustible materials such as wood, cloth, paper, rubber, and many plastics
- **Class B.** Fires involving flammable liquids, gases, and greases
- **Class C.** Fires involving energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance (When electrical equipment is deenergized, extinguishers for Class A or Class B fires may be used safely.)

Class D. Fires involving combustible metals, such as magnesium, titanium, zirconium, sodium, and potassium

Fire extinguishers (6151). The employer is responsible for the installation, inspection, maintenance, and testing of fire extinguishers.

Types of extinguishers (6152). Extinguishers should be selected for the specific class or classes of hazards to be protected in accordance with the following:

Class A. Foam, multipurpose chemical, water, and loaded-stream type extinguishers

Class B. Bromotrifluoromethane, bromochlorodifluoromethane, carbon dioxide, dry chemical, foam, and loaded-stream type extinguishers

Class C. Bromotrifluoromethane, bromochlorodifluoromethane, carbon dioxide, and dry chemical type extinguishers (Carbon dioxide extinguishers equipped with metal horns are not considered safe.)

Class D. Specific hazard type extinguishers (Extinguishers and extinguishing agents for the protection of Class D hazards must be of the types approved for use on the specific combustible-metal hazard.)

Flammable Materials

Flammable vapors (5416). No source of ignition should be permitted in any location, indoors or outdoors, where the concentration of flammable gases or vapors exceeds or may reasonably be expected to exceed 20 percent of the lower explosive limit in the working atmosphere.

Flammable liquids (5417). All open or closed containers used for storing flammable liquids must be plainly marked with an appropriate warning legend or painted with a distinctive color or otherwise distinguished from containers used for nonflammable substances. All flammable liquids should be kept in covered containers when they are not actually in use or being processed or compounded. Such liquids should not be transported from permanent storage tanks.

Electrical and other sources of ignition (5432). Open flames, spark-producing devices, or heated surfaces with a temperature sufficient to ignite vapors should not be allowed in any area where vapors may accumulate.

Guards–General Machine Hazard

Machine guards (4070). Any part of a belt or pulley drive system that has flat, crowned, or flanged pulleys that are 7 feet (2.1 m) or less above the working level must be guarded. All gears and sprockets must be guarded. Friction drives that are located 7 feet (2.1 m) or less above the floor or other working level must be guarded. The chains of sprocket and chain drives that are located within 7 feet (2.1 m) of the floor or other working level must be guarded.

Revolving and reciprocating parts (4002). Hazardous revolving or reciprocating machine parts that are not guarded by the frame of the machine or by location must be guarded properly. Keys, set screws, projections, or recesses in revolving or reciprocating parts that are not guarded by the frame of the machine or by location must be removed, made flush, or guarded.

Handrails (3214)

Stairways with more than four risers must have handrails.

Hand Tools (3556)

Hand tools should be kept in good condition and be safely stored. Broken or unsafe hand tools should be replaced. All tools should be restricted to their intended use, and they should be used only by those employees who are required and qualified to use them.

Illumination (3317)

Illumination should be adequate whether natural or artificial illumination is provided. Fixtures should be kept sufficiently clean, adjusted, and repaired so as not to impair illumination required for the safety of employees.

Machinery and Equipment (3328)

Machinery and equipment should be of adequate design and should not be used or operated at excessive speed or under stresses or loads that endanger employees.

Machinery and equipment in service should be inspected as recommended by the manufacturer and maintained in safe operating condition. Any defective equipment should be replaced.

Machines and equipment should be operated within the tonnage and weight ratings specified by the manufacturer. Those machines that are designed for a fixed location must be securely anchored.

Machine components should be designed, secured, or covered to minimize hazards caused by breakage, release of mechanical energy (e.g., broken springs), or loosening and falling. Any modifications should be in accordance with good engineering practice.

Machine power control (4001). All machines should be equipped with adequate shutoff devices so that the machine operator or another person can disconnect the power promptly in case of emergency.

Repair work (3314). Every prime mover or power-driven machine that is equipped with lockable controls must be locked in the "off" position during repair work. Machines that are not so equipped are considered in compliance with this order if they are disconnected from their source of power. In all cases caution signs with adequate wording must be placed on the controls of the machines during repair work.

Maintenance and Use of Tools and Guards

Cutting tools (4186). All saws, cutting tools, heads, shears, and knives on any machine must be kept sharp, properly set up, adjusted, and firmly secured. All point-of-operation guards must be properly adjusted and maintained in a safe and efficient working condition.

Guards (3303). Wherever there is danger of injury from flying particles or substances and such danger cannot be eliminated by the use of proper personal safety devices and safeguards, adequate shields, screens, chip guards, or enclosures must be provided.

Material Storage Areas (3241)

Stored materials should be piled, stacked, or racked to prevent them from tipping, falling, or rolling. Racks, bins, planks, bars, or blocks should be used where necessary to make the piles stable.

Medical Services and First Aid (3400)

The employer will ensure that medical personnel are readily available for advice and consultation on matters of industrial health or injury.

Where an infirmary, clinic, or hospital is not situated close to the place of work, one or more individuals must be adequately trained to render first aid. The training must be equal to that of the U.S. Bureau of Mines or the American Red Cross.

Adequate first-aid materials, approved by the consulting physician, must be readily available to the employees on every job. Such materials must be kept in a sanitary and usable condition. All first-aid materials should be inspected frequently and replenished as necessary.

Where a person's eyes or body may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body must be provided within the work area.

Noise Levels and Control

Noise levels (5097). The allowable exposures to intermittent or continuous noise are shown in Table 1.

TABLE 1

Allowable Exposures to Noise

Total exposure time, hours per day	*Sound level, decibels*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼	115

Exposure to impact or impulsive noise should not exceed a sound pressure level of 140 decibels.

Operational controls (5098). Whenever the work operation reasonably permits, exposure to excessive noise should be eliminated or at least reduced by engineering or operational controls. Whenever the exposure to noise exceeds the allowable levels, the employer must provide, and the employees must use, acceptable ear protectors.

Sanitation—General Requirements (3362)

To the extent that the nature of the work allows, work areas, storerooms, personal service rooms, and passageways should be kept clean and orderly.

Signs and Tags (6003)

The specifications for accident prevention signs and tags are as follows:

Danger signs. Danger signs should be used only where an immediate hazard exists. The colors used are red, black, and white.

Radiation warning signs. The background is reddish purple, and the lettering is yellow.

Caution signs. The background is yellow, and the panel is black with yellow letters.

Safety instruction signs. The background is white, and the panel is green with white letters.

Toilet Facilities (3364)

Every place of employment should have a sufficient number of conveniently located rest rooms for the use of employees.

Ventilation Systems (5141)

Whenever harmful dusts, fumes, mists, gases, or vapors exist or are produced under normal conditions of work, in quantities that would create harmful exposure for the employees, and prevention or elimination of the hazard is not practicable, such hazards must be controlled by the application of general ventilation, local exhaust ventilation, or other effective means.

Welding Equipment–Arc Welding (4851)

Where the work permits, the welder should be enclosed in a booth that is painted with a finish of low reflectivity such as zinc oxide and lamp black. An enclosure of noncombustible screens with a similar finish may also be used. The booth or screens must permit circulation of air at floor level. Workers or other persons adjacent to the welding area must be protected from the rays by noncombustible or flameproof screens or shields, or they must wear appropriate goggles. The welder should provide some means of warning other workers of the location of hot metal.

Fire prevention in welding operations (4848). Cutting or welding should be permitted only in areas that are or have been made firesafe. Suitable fire extinguishing equipment must be maintained ready for use while welding and cutting are being performed.

General precautions (4845). Acetylene should not be generated, piped (except in approved cylinder manifolds), or used at a gauge pressure in excess of 15 pounds per square inch (103 kPa). Oxygen cylinders, valves, regulators, or other fittings must be kept free of oil or grease. Oxygen cylinders and equipment should not be handled with oily hands or greasy materials. A jet of oxygen must never be permitted to strike against an oily surface or greasy clothes or enter a tank used to store fuel or other combustible material.

Leaking regulators, cylinder valves, hoses, piping systems, or fittings should never be used. Oxygen and fuel gases should never be used without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold. An acetylene cylinder valve should not be opened more than one and one-half turns of the spindle and preferably no more than three-fourths of a turn. Torches should be ignited by friction lighters or other devices. Matches should not be used. Acetylene should not be brought into contact with unalloyed copper, except in a blowpipe or torch.

Hose (4839). Fuel gas hose and oxygen hose should be easily distinguishable from each other. They should be coated with contrasting colors or have surface characteristics that are readily distinguishable by touch provided that either hose is labeled at intervals not to exceed 6 feet (1.8 m). Labels should be of the color usually accepted for the gas conveyed in the hose. Red is generally accepted as the color for fuel hose, and green is used for oxygen hose.

Pressure regulators (4838). Regulators or automatic reducing valves should be used only for the gas and at the pressure for which they are intended. Defective oxygen and fuel gas pressure regulators, including their gauges, should not be used. Gauges on oxygen regulators should be marked "USE NO OIL."

Storage and use of gas cylinders (4846). All gas cylinders should be protected against undue absorption of heat. Valves on empty cylinders should be closed. Valve protection caps should be in place except when the cylinders are being used. Cylinders should be secured in an upright position at all times except, if necessary, for short periods of time while the cylinders are actually being hoisted or carried. Oxygen cylinders should never be stored near highly combustible materials, especially oil and grease, or near reserve stocks of carbide and acetylene (including acetylene generators), or other fuel gas cylinders, or near any other substance that is likely to cause or accelerate fire.

Oxygen cylinders in storage should be separated from fuel-gas cylinders or combustible materials (especially oil or grease) a minimum distance of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high and with a fire-resistance rating of at least 30 minutes. All portable cylinders used for the storage and shipment of compressed gas must be constructed and maintained in accordance with the regulations of the U.S. Department of Transportation, 49 CFR, parts 171 through 179. Compressed gas cylinders should be legibly marked for the purpose of identifying the gas content. Either the chemical name or trade name of the gas can be used.

Training of operators (4799). Anyone who operates an oxygen and fuel-gas supply system, including stationary acetylene generators and oxygen and fuel-gas distribution piping systems, should be thoroughly instructed and judged competent by a designated plant authority acceptable to the Division of Industrial Safety. Printed rules and instructions covering the operation and maintenance of oxygen and fuel-gas supply equipment, including generators, and distribution piping systems should be posted in a conspicuous place,

under glass, or with other suitable means of protection.

Use of cylinders (4847). Compressed gas cylinders in portable service should be conveyed by suitable trucks to which they are securely fastened, and all gas cylinders in service should be securely held in substantial racks or secured to other rigid structures so that they will not fall or be knocked over. Cylinders must not be placed where they might form part of an electric circuit. Cylinders should be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them. (Fire-resistant shields may be used.) No attempt should ever be made to transfer acetylene from one cylinder to another or to mix gases in a cylinder.

Ventilation and personal protective equipment requirements for welding, brazing, and cutting (5150). Local exhaust ventilation systems that provide a minimum air velocity of 100 lineal feet (30.5 m) per minute in the welding zone should be used. Respiratory protective equipment should be used if the exposure level of fumes is considered harmful. Local exhaust ventilation must be provided whenever anyone is welding, brazing, or cutting materials that contain beryllium, cadmium, chromium, fluoride, lead, mercury, zinc, or stainless steel.

Work Area and Housekeeping (3273)

Permanent floors and platforms should be free of dangerous projections or obstructions, and they should be maintained in good repair and be reasonably free from oil, grease, or water. Permanent roadways, walkways, and material storage areas in yards should be maintained free of dangerous depressions, obstructions, or debris.

Permanently installed prime movers, machines, and equipment should be so arranged and placed or guarded that transported materials will not strike operators or moving parts of the machines.

Machines or equipment should be located so that the product, waste stock, or material being worked or processed will not endanger employees. Guards may be used.

Personal Safety Devices

All employees must receive instruction in the proper use of personal protective devices.

Approved Protective Devices (3380)

Protection where modified by the words *head, eye, body, hand,* or *foot* means the safe-guarding obtained by means of safety devices or safeguards of the proper type for a given exposure. The design, strength, and quality of such devices must be sufficient to eliminate, preclude, or mitigate the hazard.

The safety devices or safeguards should comply with the standards approved by the American National Standards Institute, the Bureau of Standards, the Division of Industrial Safety, or other recognized authority.

Body Protection (3383)

Body protection may be required for any employee whose work exposes him or her to hazardous or flying substances or objects.

Only clothing that is appropriate for the work being performed should be worn. Loose sleeves, ties, lapels, cuffs, or other loose clothing that can become entangled in moving machinery should not be worn.

Clothing that is saturated or impregnated with flammable liquids, corrosive substances, irritants, or oxidizing agents should be removed and properly cleaned.

Ear Protection (5099)

Whenever the exposure to noise exceeds the levels given in Table 1, the employer must provide and the employees must use acceptable ear protectors.

Eye and Face Protection (3382)

Any employee who is required to work in a location where eye hazards from flying particles, hazardous substances, or injurious light rays are inherent in the work or environment should be safeguarded by means of face or eye protection.

Suitable screens or shields that can be used to isolate the hazardous exposure may be considered adequate safeguarding for nearby employees.

The employer must provide and the employee must use suitable protection. See Table 2 for proper filter lens shade numbers.

Where eye protection is required and the employee requires vision correction, the following types of eye protection must be provided: (1) safety spectacles with corrective lenses; (2) safety goggles designed to fit over spectacles; or (3) protective goggles with corrective lenses mounted behind the protective lenses.

The wearing of contact lenses is prohibited in any working environment where the employee is exposed to harmful materials or light flashes, except when special precautionary procedures that are medically approved have been established for the protection of the exposed individual.

Design, construction, testing, and use of devices for eye and face protection must be in accordance with American National S tndard Z87.1–1968 for occupational eye and face protection.

TABLE 2

Filter Lens Shade Numbers for Protection Against Radiant Energy

	Shade No.
Shielded metal-arc welding (1/16 to 5/32 electrode)	10
Gas-shielded arc welding, nonferrous (1/16 to 5/32 electrode)	11
Gas-shielded arc welding, ferrous (1/16 to 5/32 electrode)	12
Shielded metal-arc welding (3/16 to 1/4 electrode)	12
Shielded metal-arc welding (5/16 to 3/8 electrode)	14
Atomic hydrogen welding	10 to 14
Carbon-arc welding	14
Soldering	2
Torch blazing	3 or 4
Light cutting (up to 1 inch [2.5 cm])	3 or 4
Medium cutting (1 to 6 inches [3 to 15 cm])	4 or 5
Heavy cutting (over 6 inches [15 cm])	5 or 6
Gas welding, light (up to 1/8 inch [0.3 cm])	4 or 5
Gas welding, medium (1/8 to 1/2 inch [0.3 to 1.3 cm])	5 or 6
Gas welding, heavy (over 1/2 inch [1.3 cm])	6 or 8

Foot Protection (3385)

Appropriate foot protection must be provided for employees who are exposed to foot injuries from hot, corrosive, or poisonous substances; falling objects; and crushing or penetrating actions. Those employees who are required to work in abnormally wet locations must also have proper footwear.

Shoes that are defective or inappropriate to the extent that their ordinary use creates the possibility of foot injury should not be worn.

Safety-toe footwear should meet the requirements and specifications of American National Standard Z41.1–1967.

Hand Protection (3384)

Hand protection may be required for employees whose work regularly exposes their hands to hazardous substances, cuts, or burns. The wearing of gauntlet-type or loose-cuff gloves around moving machinery should not be permitted.

Head Protection (3381)

Employees exposed to flying or falling objects and/or electric shock and burns should be safeguarded by means of approved head protection. Where there is a risk of injury from hair entanglements in moving parts or machinery or from combustibles or toxic contaminants, employees must confine their hair to eliminate the hazard.

Jewelry (3386)

Wristwatches, rings, or other jewelry should not be worn while working on machinery.

Respiratory Protective Equipment (5144)

Where it is clearly impracticable to remove harmful dust, fumes, mist, vapors, or gases at their source, as required in code sections 5142 and 5143, or where emergency protection is needed, the employer must provide and the employee must use approved respiratory equipment.

Sanitation (3387)

Protectors should be capable of being cleaned and disinfected easily. They must always be clean and in good repair. Safety devices, including protective clothing worn by the employee, should not be interchanged among the employees until the devices have been cleaned properly. Safety devices that are worn over shoes or outer clothing, no part of which contacts the skin of the wearer, need not be cleaned.

Metal Working Machines

Safety codes have been established for operators of metal working machines.

Abrading, Burring, and Polishing Machines (4237)

Exposed arbors must be guarded. Arbor ends that are not equipped with acorn nuts or the equivalent also must be guarded.

Squaring Shears (4227)

Mechanical power and foot and hand power squaring shears must be equipped with a guard that will prevent the hand of the operator from entering

the zone traveled by the knives of the shears while they are in motion.

Paper and Printing Machines

Operators of paper and printing machines should be aware of the following safety codes.

Cylinder and Rotary Presses (4440)

The in-running sides of power-operated rollers or cylinders must have a guard so arranged that the material can be fed to the rollers without permitting the operator's fingers to be caught between the rollers or cylinders.

Job Platen Press (4436)

Job platen presses with or without mechanical power should have one of the following: (1) an automatic feed that does not require the operator's hands to be placed between the platen and bed; (2) an automatic stop that will prevent the platen from closing if the hand or hands of the operator are caught between the platen and the bed; or (3) a mechanically operated guard or gate that will throw the operator's hands out of the way as the press closes.

Lithographic Press (4441)

The in-running side of the cylinder and roller should be equipped with a guard that will prevent the operator's fingers from being caught between the cylinder and roller.

Paper Cutter (4438)

Power-driven guillotine paper cutters must be equipped with (1) a nonrepeat device that will automatically lock the clutch mechanism into place so that the cutter cannot make a second stroke until the hand lever is again moved into the starting position; or (2) a buffer that will interpose a positive stop to some moving part of the machine whenever the clutch fails to perform the function of preventing the cutter from making a repeat stroke. In addition to the nonrepeat device or buffer, the cutter must be equipped with (1) a starting device that requires the simultaneous action of both hands during the cutting motion of the knife; or (2) an arrangement on the starting device or other part of the machine that will interpose a barrier or interlock between the starting lever and clutch, which must be released through a movement of the hand starting the lever before such lever can be moved to the position where it applies power to the cutter. Simultaneous operation of paper cutters by more than one operator is not permitted.

Paper Punch and Line Perforator (4443)

Mechanical or foot power punches and line perforators must be equipped with an effective device that will prevent the operator's fingers from coming between the punch and die. Machines that have less than $\frac{3}{8}$-inch (0.9-cm) clearance at the opening when in the open position need not be guarded.

Plastic Processing Machines

The following safety codes have been established for the protection of operators of machinery used for processing plastics.

Injection Molding Machine (4600)

Every injection molding machine should be guarded by one or more of the following methods. A sliding gate should be installed so that it interposes a barrier between the dies and the operator before the dies can close. The machine should be designed so that, if the gate can be opened during the die closing cycle, the die motion will be stopped immediately or it will be reversed by the opening of the gate. The sliding gate guard should extend over the top of each side of the dies a distance sufficient to make it impossible for the operator to place his or her hands between the dies while they are closing. The danger zone on the side of the machine opposite the operator's working position also should be guarded. Some machines may have a constant-pressure device or control that requires the operator to use two hands simultaneously during the entire die closing cycle.

Thermosetting Plastic Molding Press (4601)

Every thermosetting plastic molding press must have a guard that prevents the operator's hands from entering the danger zone at the point of operation.

Woodworking Machines

The following safety codes have been adopted for the protection of operators of woodworking machines.

Band Saw (4310)

A guard must be placed over all portions of a band saw blade except that portion between the guide rolls and the table. The down travel guard from the upper wheel to the guide must be adjusted so that the blade travels within the angle

or channel. The guard must be constructed of heavy material (preferably metal), and the edge of the guard must come to within ½ inch (1.3 cm) of the place formed by the inside face of the feed roll in contact with the stock being cut. Each band saw machine must be provided with a tension control device to indicate a proper tension for the standard saws used on the machine. Such a device helps to prevent saw breakage caused by improper tension. Blades must be removed from the saw promptly whenever kinks or twists develop. Brazed joints in band saws must be the same thickness as the saw blade to avoid vibration. Band saws must never be operated at speeds in excess of the manufacturer's recommended speed.

Belt Sander (4312)

Belt sanders must have enclosures over the pulleys and the unused run of the sanding belt. Rim guards are acceptable for pulleys that have smooth disc wheels, provided that on-running nip points are guarded. Guards may be hinged to permit sanding on the pulley.

Boring and Mortising Machines (4316)

Safety-bit chucks with no projecting set screws should be used on boring and mortising machines. Boring bits should be provided with a guard that encloses all portions of the bit and chuck above the material being worked. The top of the cutting chain and driving mechanism on chain mortisers must be enclosed.

Circular Ripsaw Manual Feed (4300)

A circular ripsaw must be equipped with a hood that covers the saw to at least the depth of the teeth. The hood must automatically adjust itself to the thickness of the material being cut and remain in contact with the material at the point where the stock encounters the saw. The hood may be a fixed or manually adjusted hood or guard provided the space between the bottom of the guard and the material being cut does not exceed ½ inch (1.3 cm). The hood or guard should be so designed as to prevent a kickback, or a separate attachment that will prevent a kickback should be provided. Anti-kickback devices should be designed to be effective for all thicknesses of material. A pusher stick of suitable design should be provided and used.

A spreader must be provided and fastened securely at the rear of the saw in alignment with the saw blade. This device must be used for all cutting work except grooving, dadoing, or rabbeting. The spreader should be slightly thinner than the saw kerf and slightly thicker than the saw disc. The exposed parts of the saw blade under the table must be guarded.

Combination Woodworking Machine (4320)

Each point of operation of any tool must be guarded as would be required for the tool if it were in a separate machine. Such machines must be equipped with a separate starting and stopping device for each point of operation.

Cracked Saw (4321)

Any band or circular saw found to have developed a crack must be removed from service until the width or diameter is so reduced as to eliminate the crack or until the cracked section is repaired and the tension corrected.

Disc Sander (4313)

Disc sanders must have guards around the periphery and back of the revolving disc. The space between the revolving disc and the edge of the table must not be greater than ¼ inch (0.6 cm).

Exhaust System (4324)

Whenever the chips and sawdust produced by woodworking machines accumulate on the floor so as to endanger employees, a suitable exhaust system must be provided.

Jointer (4311)

The jointer must be equipped with a cylindrical cutting head, the knife of which must not project more than ⅛ inch (0.3 cm). The jointer must have a suitable guard that automatically adjusts itself to cover that portion of the cutting head that is not protected by the material being processed. The guard must be capable of protecting the entire length of the cutting space in the table. The exposed portion of the cutting head at the rear of the fence must be covered. Wherever a knife is exposed beneath the table, it must have a guard around it. A safety pusher of suitable design must be used.

Planer, Molder, Sticker, Matcher, and Shaper (4318)

Knife heads of wood shapers and cutting heads of other machines that are not automatically fed must have guards. If they are not guarded, templates, jigs, or fixtures that prevent the operator's hands from being exposed to danger during the processing of the part must be used.

Radial Arm Saw (4309)

The saw blade must be encased on both sides in such a way that at least the upper half of the blade and the arbor ends will be covered completely. Limit chains or other positive stops must be used to prevent the saw from moving beyond the front edge of the table. Such limiting devices should be so designed and located that they can be inspected easily and maintained in good condition. Where the saw is used for ripping purposes, an antikickback device must be installed. The table should be equipped with a device that returns the saw automatically to the back of the table when released at any point of its travel; such a device should prevent the saw from rebounding. Some operators raise the front edge of the table so that the saw returns gently to the rear of the table. Ripping and plowing should always be done against the direction in which the saw turns. The direction of the saw rotation must be marked conspicuously on the hood. In addition, a permanent label not less than 1½ inches by ¾ inch (3.8 cm by 1.9 cm) must be affixed to both sides of the rear of the guard at approximately the level of the arbor, reading as follows: DO NOT RIP FROM THIS END. Such a label should be colored danger red.

Speed of Saw (4322)

The peripheral speed of a circular saw should not exceed 12,000 feet (3 657 m) per minute unless the saw has been manufactured or hammered for a higher speed and is so marked. Revolutions per minute for various diameters of saws when the peripheral speed is 12,000 feet (3 657 m) per minute are shown in Table 3.

TABLE 3
Revolutions per Minute for Saws of Various Diameters

Diameter of saw, inches (cm)	*Revolutions per minute*
8 (20)	5,732
10 (25)	4,586
12 (30)	3,821
14 (36)	3,275
16 (41)	2,866
18 (46)	2,547
20 (51)	2,292

Tenoning Machines (4317)

The cutting heads and saws of tenoning machines must be guarded.

Wobble Saws (4323)

Wobble saws should not be used in the shop.

Hazardous and Toxic Materials

Many hazardous and toxic materials are found in industrial education laboratories and shops. Some of these are described here.

Asbestos

Materials that contain asbestos should not be processed in the shop if the asbestos particles are likely to become airborne. Protective garments or equipment made of asbestos should not be worn in direct contact with the skin. Use of such garments or equipment should be limited to only those operations that require them.

Cadmium

Cadmium is a silver-white, blue-tinged, lustrous, malleable, and ductile metal. It is used in the welding and plating of low-melting alloys. The principal symptoms caused by the ingestion of cadmium are nausea, vomiting, headache, stomach pains, and muscular pains.

Carbon Monoxide

Carbon monoxide is present in automobile exhaust fumes, coal gas, furnace gas, and illuminating gas. It is formed by the combustion of carbon compounds. Carbon monoxide is the most widespread gas that is toxic to humans. Its symptoms are headache, giddiness, throbbing of the temples, nausea and vomiting, weak pulse, difficult breathing, and loss of consciousness resulting in death.

Carbon Tetrachloride

This is a clear, colorless, nonflammable, heavy liquid that has a characteristic odor like chloroform. It is used as a degreaser for metals and as a cleaning solvent for clothes. It also serves as a solvent for many substances such as oils, fats, waxes, resins, varnishes, lacquers, and rubber. It may be absorbed through the skin and cause a systemic reaction. Carbon tetrachloride also may produce a skin rash because of its defatting action.

Chloroform

Chloroform is a colorless, clear, sweet-tasting, heavy liquid that has a characteristic odor. It is extremely volatile. It is used as a solvent for waxes, fats, and oils. Chloroform also is used for alkaloids. It may be used in the manufacture of rubber. When the fumes are inhaled, they spread through the

lungs and blood to all parts of the body. An excess amount can cause damage to the heart, liver, and kidneys.

Chromium

Chromium is a silver-white, hard, brittle metal that melts at very high temperatures. It is an essential component of high-speed steel, stainless steel, and many of the corrosion-resistant alloys. Chromic acid is widely used as an electrolyte in the electroplating industry. Inhalation of chromic acid mist or chromate dust may cause inflammation of the mucous membranes and ulceration and perforation of the nasal septum.

Copper

Copper, in very low concentration, is an essential element of human metabolism, but it is toxic when it is present in large quantities. It is the principal constituent of brass, bronze, and many of the specialty alloys. Inhalation of copper fumes or any dust or mist that contains copper salts causes irritation of the upper respiratory tract, nausea, and possible pigmentation of the skin and hair. Metal fume fever may result from exposure to the fumes.

Ethylene Glycol

Ethylene glycol is a colorless, odorless, syrupy liquid with a sweetish taste. It is mainly used as an antifreeze for the cooling systems of motor vehicles.

Gasoline

Although the principal hazards involving gasoline are explosion and fire, it also has toxic properties. Leaded gasoline is extremely dangerous because it contains tetraethyl lead. In addition, gasoline with a high percentage of sulfur compounds may have toxic effects due to the hydrogen sulfide present.

Hydrochloric Acid

Hydrochloric acid has a pungent odor and produces fumes. The pure acid is colorless, but the commercial product is often yellowish from traces of iron salts. One of the strongest known acids, it is used in the soldering process. A few drops of concentrated acid entering the windpipe may produce death rapidly.

Lead

Lead is a soft gray metal that is extremely malleable and ductile. It is protected from erosion by the formation of a film of gray oxide. Lead poisoning may occur through the inhalation or ingestion of lead fumes or dusts. This results in the accumulation of lead in the bones and tissues of the body.

Metallic Fumes

Almost any readily volatilized metal may cause a metal fume fever known as brass chills, oxide chills, zinc oxide fever, brass founders ague, or metal shakes. The toxicity apparently is related to the small size of the particles rather than to the chemical nature of the metal.

Methyl Alcohol

Methyl alcohol is a clear, colorless liquid that possesses a characteristic wine-like odor and a burning taste. It is used as a solvent for shellacs and resins, as an antifreeze for automobile engines, and as a motor fuel. It also is used in the manufacture of many organic chemicals. It is toxic in small doses, even if inhaled. In the concentrated form it affects the optic nerve and may cause blindness.

Methyl Ethyl Ketone

Methyl ethyl ketone is a colorless, highly flammable liquid similar to acetone. It is an excellent solvent that is used principally in the synthetic resin industries. It also is used in the manufacture of smokeless powder and paint remover. This liquid is distinctly irritating to the nose and eyes.

Smoke and Gas from Fires

Any poisoning that results from breathing smoke and gas from burning wood is primarily due to carbon monoxide. The carbon dioxide, which always is present in fire gases, stimulates respiration and thereby increases the inhalation of other gases.

Toluene

Toluene is a colorless, volatile, flammable liquid with a benzene-like odor. It is used as a solvent; as a component of chemical synthesis; and as a thinner for paints, varnishes, enamels, and lacquers. Inhalation of the vapors is the primary method of absorption. Dermatitis may result from skin contact.

Turpentine

Turpentine is used widely, particularly in the paint and varnish industry. It is a weak narcotic, a strong irritant, and a systemic poison. When ingested, it acts as a violent irritant to the digestive

system and, after absorption, may cause kidney damage.

Zinc Oxide

Zinc oxide is a powdery substance that is white when cold but turns yellow when it is heated. It is used in paint as a pigment, in cosmetics, in quick-drying cements, in galvanized metal coatings, and in white printing inks. It also is used in the manufacture of glass and auto tires. It may be used in dental cements. Inhalation of the fumes may cause an illness known as metal fume fever. The symptoms resemble those of influenza and usually occur a few hours after removal from the exposure.

Safety Color Code

A safety color code has been established by the Occupational Safety and Health Act (OSHA). In accordance with OSHA's Safety Color Code Section 1910.144, physical hazards and safety equipment must be marked with designated colors.

Red

Red is used as the basic color for the identification of fire protection equipment. The same color should be used on the housing, wall, or support to identify the location of such equipment. Emergency stop bars, buttons, or electrical switches on hazardous machines should be red.

Orange

Orange is used as the basic color for designating the dangerous parts of machines or energized equipment. Orange should be used to emphasize hazards when enclosure doors are open or when gear bolts and other guards around moving equipment are open or removed, exposing unguarded hazards.

Yellow

Yellow is the basic color for designating caution and for marking physical hazards. Solid yellow, yellow and black stripes, or checkers (yellow with suitable contrasting background) can be used interchangeably. The combination that attracts the most attention should be used.

Green

Green is used to designate safety and the location of first-aid equipment (other than fire-fighting equipment).

Blue

Blue is the basic color for designating caution. It should be used to warn against the operation of or the movement of equipment that is under repair.

Purple

Purple designates radiation hazards.

Black and White

Black, white, or a combination of these two are the basic colors used for traffic or housekeeping markings.

The colors must meet the tests specified in ANSI 253.1–1967, Section 3, Color Definitions, for marking physical hazards.

Appendix A
Terminology

ANSI. American National Standards Institute. This formerly was known as the American Standards Association.

CAC. California Administrative Code, Title 8, Industrial Relations. Sections of the *General Industrial Safety Orders* and the *Electrical Safety Orders* are listed using the section numbers in the code.

CAL/OSHA. California Occupational Safety and Health Act of 1973. This law provides job safety and health protection for workers. The California Agriculture and Services Agency, operating through the Department of Industrial Relations, has primary responsibility for administering the act. Job safety and health standards are promulgated by the Occupational Safety and Health Standards Board. Employers and employees are required to comply with these standards. Enforcement is carried out by the Division of Industrial Safety within the Department of Industrial Relations.

Code. For purposes of this guide, the *General Industry Safety Orders* and the *Electrical Safety Orders* are referred to as "the code."

GISO. General Industry Safety Orders

NSC. National Safety Council

OSHA (Public Law 91-596). Federal Williams-Steiger Occupational Safety Health Act of 1970. This law requires industry to conform to a set of safety standards. In addition, most states have passed similar codes.

Shop. For purposes of this guide, the classroom or laboratory used for industrial education programs, including industrial arts, industrial occupations, and vocational education, is referred to as "the shop."

UL. Underwriters' Laboratories. This agency maintains standards for industry.

Appendix B
Facility Safety Inspection List

State code requirements (code number in parentheses)	*Satisfactory*	*Unsatisfactory*
Adequate light and ventilation, window area (3317)	_____	_____
Means of access around equipment (3272)	_____	_____
Sufficient illumination (3317)	_____	_____
Exits properly marked (3228)	_____	_____
Toilet facilities available (3364)	_____	_____
Handrails on stairways (3214)	_____	_____
Hand tools in good condition (3556)	_____	_____
Hand tools stored safely (3556)	_____	_____
Materials and supplies stored safely (3241)	_____	_____
Flammable liquids plainly marked (5417)	_____	_____
Flammable liquids stored safely (5417)	_____	_____
Eye protective devices available (3382)	_____	_____
Head protective devices available (3381)	_____	_____
Hair protection required (3381)	_____	_____
Body protective devices available (3383)	_____	_____
Appropriate clothing worn in shop (3383)	_____	_____
Hand protective devices available (3384)	_____	_____
Foot protective devices available (3385)	_____	_____
Jewelry not worn during activities (3386)	_____	_____
Proper cleaning of safety devices (3387)	_____	_____
Person trained in first aid available (3400)	_____	_____
First-aid kit available (3400)	_____	_____
Sanitation (3362)	_____	_____
Belts and pulleys guarded (4070)	_____	_____
Gears and sprockets guarded (4075)	_____	_____
Friction drives guarded (4076)	_____	_____
Chains and sprockets guarded (4077)	_____	_____
All guards on machines and properly adjusted (4186)	_____	_____
Compressed air controlled for use in shop (3301)	_____	_____
Instruction posted for lighting gas furnaces (3311)	_____	_____
Lockable controls on equipment to be locked off when servicing and repairing equipment (3314)	_____	_____
Control of noise level (5098)	_____	_____
Personal protective equipment for noise (5099)	_____	_____
Control of ventilation (5141)	_____	_____
Local exhaust ventilation available (5141)	_____	_____
Respiratory protective equipment available (5144)	_____	_____

State code requirements (code number in parentheses)	*Satisfactory*	*Unsatisfactory*
Abrasive wheels properly enclosed and guarded (3577)	_____	_____
Abrasive wheels properly secured to bench or floor (3576)	_____	_____
Abrasive wheel work rests properly adjusted (3577)	_____	_____
Air compressor intake lines not located in an atmosphere containing flammable gases (3518)	_____	_____
Gas cylinders stored properly and secured (4846)	_____	_____
Cylinders away from electric circuits (4847)	_____	_____
Oxygen cylinders located properly (not stored near fuel gas) (4846)	_____	_____
Proper instruction given and posted for setting up welding equipment (4799)	_____	_____
Machine power controls (switches) (4001)	_____	_____
All equipment mounted properly to prevent damage to electrical connections (2305.4)	_____	_____
No open exposed wiring (2420.17)	_____	_____
Proper outlets, switches, junction boxes, and fittings properly grounded (2510.58)	_____	_____
30-inch clearance around electrical panels and junction boxes (2340.27)	_____	_____
Flexible cords of approved type (2305.4)	_____	_____
Electrical equipment properly grounded (2510.58)	_____	_____
Portable equipment cords grounded (2510.58)	_____	_____
All switches of approved type enclosure (2305.4)	_____	_____
Switches and breakers not exposed to mechanical damage (2340.26)	_____	_____
Magnetic switches and controls to prevent automatic restarting after shutdown (2530.43)	_____	_____

Recommendations from State Planning Guide

The following space allotments are recommended for shop or laboratory facilities:

Junior high school laboratory (50 square feet [4.7 m^2] per student minimum)	_____	_____
High school laboratory (75 square feet [7 m^2] per student minimum)	_____	_____
Aisles of travel in laboratory (4 feet [1.37 m] in width)	_____	_____
Spacing between benches and machinery (3 feet [91 cm])	_____	_____
Operators' zones around machines clearly identified (should be designated on the floor by taped or painted lines)	_____	_____
Nonskid materials on the floor in operators' zones	_____	_____
Artificial lighting (a minimum of 50 footcandles [538 lm/m^2] in laboratory activity area and 100 footcandles [1 076 lm/m^2] in classroom areas)	_____	_____

Selected References

Accident Prevention Manual for Training Programs. Chicago: American Technical Society, 1975.

California Administrative Code, Electrical Safety Orders. Sacramento: California State Department of Industrial Relations, 1975.

California Administrative Code, Title 5, Education. Sacramento: California State Department of General Services, 1975.

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Interpretation of O.S.H.A. for Industrial Education. Washington, D.C.: American Council of Industrial Arts Supervisors, 1975.

Kigin, Denis J. *Teacher Liability in School-Shop Accidents.* Ann Arbor, Mich.: Prakken Publications, Inc., 1973.

Planning and Equipping Industrial Arts Facilities. Sacramento: California State Department of Education, 1971.

Publications Available from the Department of Education

Industrial Education Safety Guide is one of approximately 400 publications which are available from the California State Department of Education. Of special interest to the users of this document are the following:

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